

Los Alamos

NATIONAL LABORATORY

memorandum

LANSCCE Division
Group LANSCE-1

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SUBJECT: SNS PROTOTYPE CHOPPER

A prototype of the SNS Fast Beam Chopper has been designed, fabricated, and tested. The intent of this memo is to document the design/fabrication process and to review problems that were encountered during fabrication. Lessons learned will be addressed in the final design of the chopper.

DESIGN/FABRICATION PROCESS

A set of engineering drawings (95Y-225658) was produced in order to define the physical shape of the structure. Both mechanical and electromagnetic requirements were incorporated into the design. The entire structure is approximately 50 cm long x 13 cm wide x 2.4 cm high. Since the start of fabrication for the prototype unit, the design requirement for the length of the meander line has been reduced to 35 cm.

The meander line required a material with high electrical conductivity on a substrate with a low dielectric constant. A composite material commonly used in the manufacture of printed circuit boards was chosen for our application. The material (Rogers Corp. RT6002) is .100" thick with a .020" thick copper back plate. The profile of the meander strip-line was drawn in *AutoCad* format and was given to Tom Cote (LANSCE-8). Tom translated the data into a "gerber" format and created the mask of the notched meander pattern. The electronic data and the material were then transferred to Multi-Plate Circuits Inc. in Dallas, TX for fabrication. The etched copper pattern was then produced.

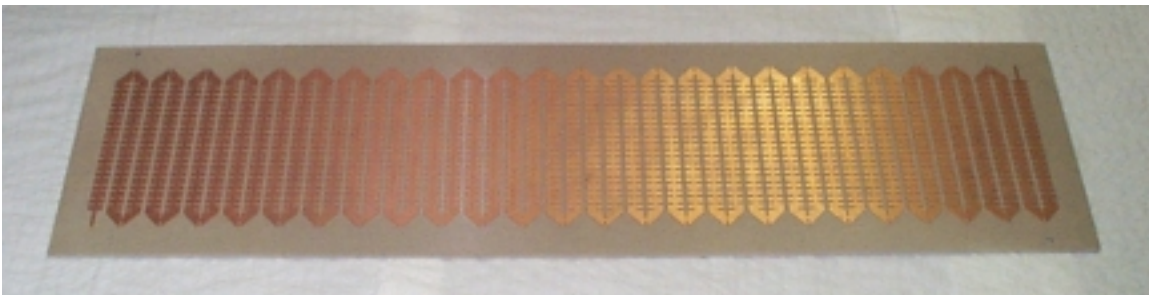


Fig. 1 Etched copper pattern for meander line.

The job was then handed over to Orlando Smith (ESA-WMM). The job was assigned, via the RRB program, to Bogue Manufacturing in Albuquerque, NM for fabrication. Orlando acted as a liaison between LANSCE-1 and Bogue. IGES files of the *Unigraphics* solid models were transferred to Bogue for CNC programming. Slots were put in,

mounting holes were drilled, and dielectric material was removed from the underside of the substrate. Bogue also fabricated the base plate and the cover plate for the assembly. Orlando was also involved in getting the parts inspected after fabrication. Difficulties that transpired during fabrication will be addressed in the “Lessons Learned” section of this memo.

After the machining of the substrate was complete, it was impossible to maintain the flatness tolerance on the copper surface. This was due to the removal of the dielectric material on the underside of the substrate. A solution to this problem was to epoxy the substrate to the base plate. Eccobond 45 / Catalyst 15 epoxy was used for this process. Several tests to determine the bonding strength of the epoxy were conducted prior to actually epoxying the assembly together. A test fixture was designed and fabricated (SK-AT1-529). A thin layer of epoxy (.003”-.004”) mixed with a “rigid” mix ratio yielded the best results. It was also determined that a “weighted” cure time of 48 hours with 100 lbs./sq. in. would be necessary. Test results indicated that it took 7 in./lbs. of torque to break the bond towards the ends of the fixture and 15 in./lbs. of torque to break the bond towards the middle of the fixture. Note: dielectric material actually broke apart in places before the epoxy bond broke.

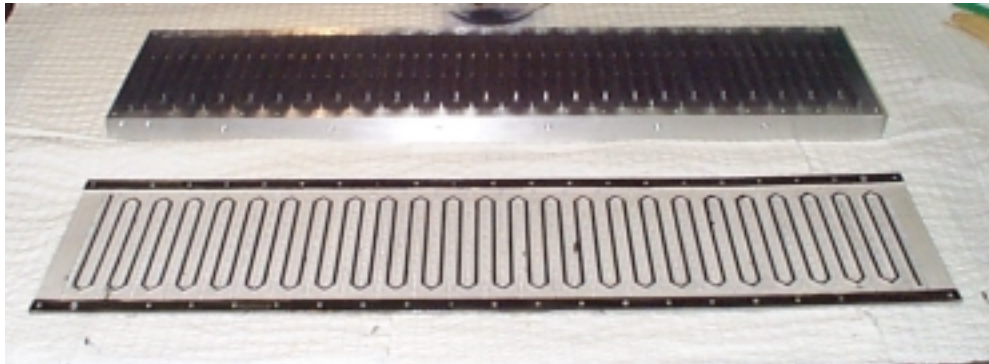


Fig. 2 Epoxied surfaces of the dielectric. Also shown: aluminum base plate.

In order to ensure uniform weight distribution over the entire length of structure, a precision fixture was designed and fabricated by LANSCE-1 (95Y-225659). This fixture was placed over the epoxied assembly and a wiffletree was constructed over the fixture. Approximately 2000 lbs. of weight was then placed over the entire assembly and the epoxy was allowed to cure for over two days.

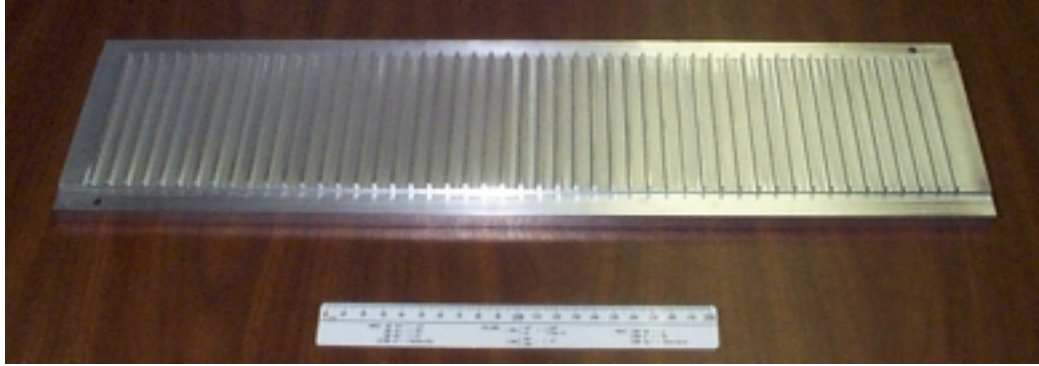


Fig. 3 Precision fixture.



Fig. 4 "Weighted" assembly.

Some preliminary tests have been conducted and the results have been quite favorable. The copper surface on the meander line is flat within .001". Impedance measurements taken by John Power (SNS-PO) were 50.0 ohms \pm .3 ohms throughout the entire length of the structure. More tests will be conducted in order to determine if the joining technique used is suitable for our application. It is unclear whether there are any voids in the epoxy. It is also unclear how the epoxy will age, so more impedance measurements will be taken periodically over a period of time. Furthermore, we have yet to determine how the structure will perform under vacuum. The structure will be put through several vacuum cycles with impedance measurements taken at each stage. Finally, the structure will be left under vacuum for a couple of weeks with impedance measurements taken daily.

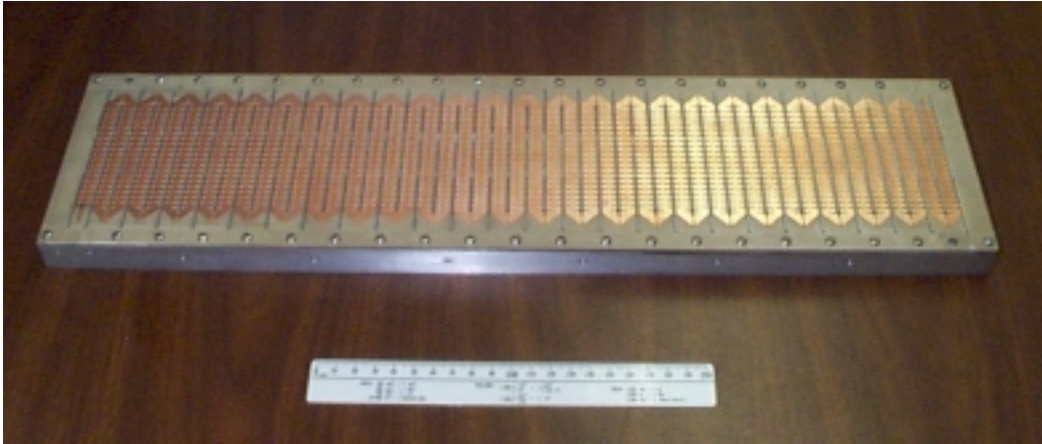


Fig. 5 Epoxied Prototype Chopper Assembly.

LESSONS LEARNED

There were a few items that came up during fabrication that raised some concerns. These items will be addressed in the final design:

- During the etching process, an overall tolerance was not specified for the artwork. During inspection, it was discovered that the strip centerline to centerline distance was over the nominal distance by an average of .0009". This created some misalignment with the separators on the base plate.
- During the machining of the dielectric, a cool mist spray was initially used. This resulted in the material "gumming up". The use of a flood coolant eased the machining process.
- During the fabrication of the base plate, a "loop" program was written to generate one of the separators. The "loop" was then copied over 49 times to generate the remaining separators. An error of .0004" was discovered in the original "loop" and that error was translated over the entire length of the structure. This resulted in the re-fabrication of the plate.
- After the assembly was epoxied and measurements were taken, it was discovered that the top copper surface of the meander line was about .004" above the top surface of the metal separator. This was due to the epoxy between the two pieces. If epoxy is going to be used in future joining processes, the thickness needs to be taken into account.

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